THE INFLUENCE OF GLOBAL-SELFHEATING ON THE YARKOVSKY AND YORP EFFECTS. B. Rozitis[1], S. F. Green[1], S. R. Duddy[2], A. Fitzsimmons[3], M. Hicks[4], S. C. Lowry[2], C. Snodgrass[5], P. R. Weissman[4] and S. D. Wolters[4]. [1]Department of Physical Sciences, The Open University, Milton Keynes, UK, b.rozitis@open.ac.uk. [2]Centre for Astrophysics and Planetary Sciences, The University of Kent, Canterbury, UK. [3]Department of Physics and Astronomy, Queen's University Belfast, Belfast, UK. [4]Planetary Science Section, Jet Propulsion Laboratory, Pasadena, US. [5]Max-Planck-Institut für Sonnensystemforschung, 37191 Katlenburg-Lindau, Germany.

Introduction: In addition to collisions and gravitational forces, it is now becoming widely accepted that photon recoil forces from the asymmetric reflection and thermal re-emission of absorbed sunlight are primary mechanisms governing the dynamical and physical evolution of asteroids. A net force causes an asteroid's orbit to drift (Yarkovsky effect) and a net torque alters its spin state (YORP effect). The two effects are coupled and have a number of important implications in asteroid science (e.g. [1] and references therein). To date, there have been two confirmed detections of the Yarkovsky effect (Golevka [2] and 1992 BF [3]) and three confirmed detections of the YORP effect (YORP [4], Apollo [5], and Geographos [6]).

Previous studies have shown the YORP effect to be sensitive to detailed small-scale variations in an asteroid's shape model [7][8], which suggest that the error in any YORP effect prediction could have unity order. It remains uncertain as to whether these findings are a result of specific model assumptions and/or model simplifications. In an attempt to improve the accuracy of Yarkovsky and YORP effect models, our previous work has investigated the influence of rough surface thermal-infrared beaming [9]. We found that beaming, on average, enhanced the Yarkovsky orbital drift whilst it dampened the YORP rotational acceleration by orders of several tens of percent. The Yarkovsky effect was sensitive to only the average degree of surface roughness, and the YORP effect was senstive to both the average degree and the spatial distribution of surface roughness.

To gain further accuracy, this work concentrates on including global-selfheating effects in the predictions (i.e. mutual selfheating within large scale concavities of an asteroid shape model) which has been dismissed or neglected in all previous models.

The Advanced Thermophysical Model: Our Yarkovsky and YORP effect model is adapted from the Advanced Thermophysical Model (ATPM) which was developed to determine the thermal-infrared emission from atmosphereless planetary bodies [10]. The ATPM explicitly incorporates sub-surface heat conduction, shadowing, multiple scattering of sunlight, selfheating, and rough surface thermal-infrared beaming effects. It has been verified by reproducing the well studied lunar thermal-infrared beaming effect, and has been successfully applied to a wide variety of planetary bodies.

Influence of Global-Selfheating: To characterise the influence global-selfheating typically has on the Yarkovsky and YORP effect predictions, tests with and without global-selfheating were performed on a sample of 100 randomly-generated gaussian-spherical asteroids and on the real shapes of several asteroids. Our results demonstrate that large differences can arise when making YORP rotational acceleration predictions for asteroids with relatively large concavities and/or with weak YORP effects. For example, Fig. 1 demonstrates that global-selfheating has a very large influence on the YORP rotational acceleration predictions for the highly irregular-shaped asteroid Golevka. In contrast, global-selfheating does not appear to significantly affect the Yarkovsky orbital drift predictions.

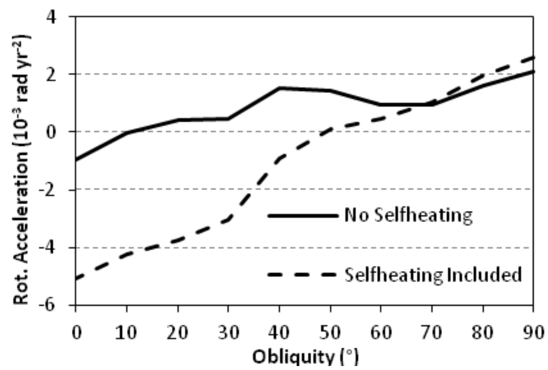

Figure 1: YORP rotational acceleration acting on Golevka.

Other Applications: The ATPM is capable of simultaneously interpreting asteroid thermal-infrared observations and for predicting the Yarkovsky and YORP effects. It is currently being applied to observations of fast-rotating near-Earth asteroids (NEAs) obtained by the European Southern Observatory Very Large Telescope (ESO VLT) between April 2010 and December 2011[1].

References: [1] Bottke W. F. et al. (2006) *Annual Review of Earth and Planetary Sciences*, 34, 157-191. [2] Chesley S. R. et al. (2003) *Science*, 302, 1739-1742. [3] Vokrouhlický D. et al. (2008) *AJ*, 135, 2336-2340. [4] Lowry S. C. et al. (2007) *Science*, 316, 272-274. [5] Kaasaleinen M. et al. (2007) *Nature*, 446, 420-422. [6] Ďurech et al. (2008) *A&A*, 489, L25-L28. [7] Breiter S. et al. (2009) *A&A*, 507, 1073-1081. [8] Statler T. S. (2009) *Icarus*, 202, 502-513. [9] Rozitis B. and Green S. F. (2012) *MNRAS*, submitted. [10] Rozitis B. and Green S. F. (2011) *MNRAS*, 415, 2042-2062. [1]Based on observations performed at the ESO La Silla and Paranal Observatories in Chile (program IDs 185.C-1033, 185.C-1034).